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Project Summary

Organic Emissions from Ferrous Metallurgical Industries: Compilation of Emission Factors and Control Technologies

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This report presents a review and analysis of the information and data available in the public domain on organic emissions from the ferrous metallurgy industry, specifically the iron and steel, iron foundry, and ferroalloy industries. Emission sources and information gaps are identified and the credibility ratings of organic emissions data are reported. Organic emission factors for various source categories in these industries are compiled. The content of this report, which reflects accurately the present state of knowledge about organic emissions in the iron and steel, iron foundry, and ferroalloy industries, may be used as a guide to plan and direct programs for further studies, particularly a program to characterize more precisely those classes of organic species (comprising the volatile organic compound category) that are released from the potential sources identified.

This Project Summary was developed by EPA's Industrial Environmental Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

For the most part, environmental studies and regulatory control activities in the iron and steel, iron foundry, and ferroalloy industries have focused on atmospheric particulate emissions and waste water effluent qualities. The studies relating to organic emissions have involved primarily the emission of polynuclear organic materials (POMs) from coke production and by-product recovery facilities and lubricant organics from mill rolling and finishing operations. There is no comprehensive list of volatile organic compound (VOC) emission factors from the ferrous metallurgy industry.

Purpose and Scope

The original purpose of this study was to list VOC emission factors for the iron and steel, iron foundry, and ferroalloy industries based solely on data and information available in the open literature. This would provide information on the present status of VOC emission data from these industries and offer guidance in selecting further study efforts. The study's objectives were: to identify VOC emission sources within these industries; to quantify and rate the credibility of emission factors for the identified sources; to identify information and database gaps; to assess the effectiveness of VOC control technology in use; and to estimate the effectiveness of alternate control technologies, processes, and operating methods on VOC emissions.

Once the data collection phase was well under way, it became apparent that virtually no specific VOC emissions data

were available. Therefore, the decision was made to broaden the species definition to the general category organic emissions. To provide an overview of organic emission factors of various sources within the ferrous metallurgy industry, engineering analyses and estimates have been used to supplement the actual data where data gaps were found. Where significant operating variations occur in a particular process and different types of control systems may influence emissions, several emission factors or a range of emission factors are reported.

Caveat

Several comments about the overall credibility of the organic emission factors reported herein are warranted to caution the reader in using the results and in drawing conclusions from the data presented.

First, the paucity of suitable and complete organic emission data required the extensive use of engineering analyses in the estimation of emission factors to provide an overview of the relative organic emissions from the various point sources within the ferrous metallurgy industries. These estimates, based on the available fragmentary data whenever possible and on engineering experience, however, should represent emission factors within the range of process and operating variability that might be found for the iron and steel, iron foundry, and ferroalloy industries. In preparing the engineering estimates, assumptions were conservative so that the derived emission factors might represent estimates on the upper bound of the actual organic emissions. This conservative approach ensured that all significant sources of organic emissions in the ferrous metallurgy industries were identified.

Second, the ambiguity inherent in the classifications used for reporting organic emissions data (e.g., hydrocarbons, organic solvents, alphatic organics, aromatic organics, extractable organics, and chromatographicable organics) made consistent and precise identification of the types of organic compound emissions virtually impossible. Consequently, comparative evaluation of organic emissions factors from different point sources is uncertain because a consistent basis for calculation of the emission factors could not be established. For example, in some cases the organic emissions (on a mass basis) were expressed as methane, which distorts the actual mass emissions of organics; and in other cases, only POM or extractable emissions were measured and reported.

Although the above problems encountered in this study impact the determination of the true organic emission factors for the point sources within the ferrous metallurgy industry, the reported emission factors should be within the range of process and operating variability that exists for similar sources throughout this industry. Also, this study does reflect accurately the present state of knowledge about organic emissions in the iron and steel, iron foundry, and ferroalloy industries. It can be used as a guide to plan and direct programs for further studies, particularly a program to characterize more precisely those classes of organic species (comprising the VOC category) that are released from the potential sources identified in this study.

Summary

The ferrous metallurgy industry (which includes the iron and steel, iron foundry, and ferroalloy industries) is one of the largest industries in the U.S. in terms of annual sales, people employed, and production volume.

Over the past decade, however, this industry has been under economic stress; and has undergone a forced state of change, characterized by dramatic shifts in annual production, by major plant closings, by business diversification of major steel corporations, and by a general, although variable, decline in the work force. Although the ferrous metallurgy industry has reduced its production capacity significantly through plant closings, the industry is presently still operating well below its available capacity. Domestic production in the ferrous metallurgy industry over the past two decades has declined to 1981 annual production levels of 120,828,000 tons of steel, 12,390,000 tons of iron foundry castings, and 1,274,000 tons of ferroalloys, while domestic consumption of these commodities has shown generally a steady increase over the same period.

Although the ferrous metallurgy industry, specifically the iron and steel industry, is not generally viewed as a major industrial source of VOC emissions when compared with the petroleum and organic chemicals industries whose products themselves are largely volatile organics, this industry can be potentially a significant contributor to VOC emissions as well (as other classes of organic compounds) because of its very large size and the quantities of organic materials used in the manufacturing process. For example, the iron and steel industry consumes annually more than 343,000 tons of lubricants of which up to about 15 percent may enter the atmosphere as organic pollutants. This industry is an even larger consumer of other organics such as coal and fuels, a portion of which also become organic pollutants in the atmosphere.

This study was initially directed toward a review and analysis of the information and data available in the public domain on VOC emissions from the ferrous metallurgy industry, specifically the iron and steel, iron foundry, and ferroalloy industries. However, the available emission data, for the most part, do not include specific measurements of VOC emissions. Since VOCs represent a component of organic emissions from point sources in the ferrous metallurgy industry, this study examined the broader class of organic emissions from this industry to provide an upper limit or bound on the potential amount of VOC emissions. Therefore, the organic emissions factors reported herein represent more precisely total organic emissions to the atmosphere rather than the more specific VOC emissions.

Table 1 summarizes the organic emission factors for various source categories in the iron and steel, iron foundry, and ferroalloy industries. The emission factor ratings included in the table reflect the relative credibilities of the emission factors for estimation of organic emissions for the source categories. Also included in the table is an estimate of the annual organic emissions from these three industries based on 1981 production data.

The credibility rating assigned to each emission factor in the table is an estimate of the factor's reliability or credibility as an accurate and representative measure of the emissions for the particular source throughout the industry. These ratings are based on the procedures and scales in the report "Technical Procedures for Developing AP-42 Emission Factors and Preparing AP-42 Sections," 1980, prepared by EPA's Office of Air Quality Planning and Standards.

As can be seen from the table, the organic emissions from the iron and steel industry represent nearly 96 percent of the total organic emissions from the whole ferrous metallurgy industry. By-product cokemaking and sinter production account for about 43 percent and 36 percent, respectively, of the total emissions based on emission factors given a

Table 1. *Summary of Organic Emission Factors for the Iron and Steel, Iron Foundry, and Ferroalloy Industries*

	Organic Emission Factor (lb/ton)[a,g]	Rating	Normalized Organic Emission Factor (lb/ton)[b,g]	Annual Organic Emissions (1981) (tons)[g]
Iron and Steel Industry[c]				
Byproduct cokemaking	11.5	C	3.90	235,614.6
Blast furnace ironmaking	1.98	D	1.17	70,684.4
Sinter production	4.80	C	3.20	193,324.8
Basic oxygen process steelmaking	0.0029	C	0.0018	108.7
Electric arc furnace steelmaking	0.348	C	0.0995	6,011.2
Open hearth furnace steelmaking	0.168	-	0.0188	1,135.8
Hot forming and finishing operations	0.643	D	0.184	11,116.2
Total	-	-	8.57	517,995.7
Iron Foundry Industry[d]				
Cupola furnace melting	0.181	C	0.195	1,208.0
Electric arc furnace melting	0.347	C	0.160	991.2
Inoculation	0.0052	C	0.0013	8.1
Metal pouring and cooling	0.136	C	0.209	1,294.8
Casting shakeout	1.23	C	1.89	11,708.6
Total	-	-	2.46	15,210.7
Ferroalloy Industry[e]				
Open submerged arc furnace smelting				
Silicon metal alloys	51.6[f]	B	10.2	6,497.4[f]
Ferrosilicon alloys	4.4	B	1.86	1,184.8
Ferromanganese alloys	3.72	B	0.340	216.6
Ferrochromium alloys	4.06	D	0.645	410.9
Covered submerged arc furnace smelting				
Ferrosilicon alloys	4.48	B	0.225	143.3
Ferromanganese alloys	0.80	B	0.0479	30.5
Ferrochromium alloys	3.14	D	0.0614	39.1
Total	-	-	13.4	8,522.6
Total for ferrous metallurgy industry:				541,729.0

[a] *Emission factors based on ton of process or operation product output (e.g., coke, iron, sinter).*
[b] *Emission factors normalized to lb/ton finished product (i.e., total steel products, net castings, total ferroalloys).*
[c] *1981 steel production 120,828,000 tons.*
[d] *1981 iron casting production 12,390,000 tons.*
[e] *1981 ferroalloy production 1,274,000 tons.*
[f] *Emission factors and annual organic emissions do not include low boiling point (C_1-C_6) hydrocarbons.*
[g] *Conversion factors: 1.0 lb/ton = 0.5 kg/MT (MT = metric ton = 1.0 Mg) and 1.0 ton = 0.9072 MT.*

"C" reliability rating. On a per ton of finished product basis, however, the ferroalloy industry has the highest overall organic emission factor, with the iron and steel industry second, and the iron foundry industry the lowest. But the ferroalloy industry has the lowest quantity of organic emissions of the three industries because of its low production level.

The organic emission factors summarized in the table represent uncontrolled organic emissions which, in some cases, include emissions released to the atmosphere through particulate pollution control devices in current use. Except for some by-product cokemaking facilities, the pollution control devices in use are designed primarily to control particulate emissions to the atmosphere. These devices include mainly baghouses, wet scrubbers, and electrostatic precipitators (ESPs). Although data on the efficiency of these devices in capturing organic emissions from ferrous metallurgical industry sources are very limited, wet scrubbers, as might be expected, appear to be more effective in organics removal than the other devices. For example, in the ferroalloy industry, scrubber efficiences for organics of 65 to 88 percent compared to 13 to 65 percent for baghouses have been reported.

In some cases, changes in production procedures and operating practices have been used to reduce organic emissions. Most notably in the iron and steel industry, for example, the use of fresh quench water in the coke quench tower and the restricted use of scrap and mill scale containing high levels of oil contaminants have significantly reduced organic emissions and have been generally adopted as standard practice. Similarily in the iron foundry industry, an increase in the cooling time of castings before mold shakeout significantly reduces organic emissions during shakeout operations.

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The complete report, entitled "Organic Emissions from Ferrous Metallurgical Industries: Compilation of Emission Factors and Control Technologies," (Order No. PB 84-141 548; Cost: $13.00, subject to change) will be available only from:
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